IS 9000-8 (1981): Basic environmental testing procedures for electronic and electrical items, Part 8: Vibration (sinusoidal) test [LITD 1: Environmental Testing Procedure]

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART VIII VIBRATION (SINUSOIDAL) TEST

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART VIII VIBRATION (SINUSOIDAL) TEST

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART VIII VIBRATION (SINUSOIDAL) TEST

0. FOREWORD

0.1 This Indian Standard (Part VIII) was adopted by the Indian Standards Institution on 25 September 1981, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The differences in environmental testing procedures for component type items and equipment type items are fast disappearing in the context of technological developments. It is, therefore, felt necessary to have uniform testing procedures wherever possible. This series of standards on environmental testing procedures (IS : 9000) have been prepared with this objective. This is also in line with the principle adopted by IEC/TC 50 'Environmental Testing' in developing unified series of standards on environmental testing procedures by the International Electrotechnical Commission.

0.2.1 It is proposed to withdraw the existing Indian Standards, namely, IS : 589-1961* and IS : 2106† series dealing with environmental tests for electronic components and equipment respectively, as soon as the tests mentioned therein are covered in the new series (IS : 9000).

0.3 The vibration (sinusoidal) test is applicable to electrical/electronic items which, during transportation or in service, may be subjected to conditions involving vibration of a harmonic pattern, generated primarily by rotating, pulsating or oscillating forces, such as occur in ships, aircraft, land vehicles, rotorcraft and space applications or are caused by machinery and seismic phenomena. It consists, basically, of subjecting an item to sinusoidal vibration over a given frequency range or at discrete frequencies for a given period of time.

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

†Environmental tests for electronic and electrical equipment.

0.4 This standard (Part VIII) covers the test procedure for vibration (sinusoidal) test. The guidance details are covered in IS : 9001 (Part XIII)-1981*.

0.5 This standard is largely based on the following:

Doc: 50A (Central Office) 145 Draft — Revision of IEC Pub 68-2-6 (1970) Test Fc — Vibration (Sinusoidal). International Electrotechnical Commission (IEC).

JSS 55555-1977 Environmental Test Methods for Electronic and Electrical Equipment. Directorate of Standardization, Ministry of Defence, India.

0.6 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960†.

1. SCOPE

1.1 This standard (Part VIII) gives procedure for vibration (sinusoidal) test for electronic and electrical items as a part of basic environmental testing procedures.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following terms and definitions, in addition to those given in IS : 9000 (Part I)-1977‡ shall apply.

2.1 Sweep Cycle — A traverse of the specified frequency range once in each direction, for example, 10-150-10 Hz.

2.2 Distortion (d)

$$d = \frac{\sqrt{a_{tot}^2 - a_1^2}}{a_1} \times 100 \text{ (in percent)}$$

where

a_1 = the rms value of the specified acceleration at the driving frequency, and

a_{tot} = the total rms value of the applied acceleration (including the value of a_1).

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.
†Rules for rounding off numerical values (*revised*).
‡Basic environmental testing procedures for electronic and electrical items: Part I General.

2.3 Control — Control by measurements made at reference point and control points related to the fixing points of the equipment.

2.4 Control Point — Normally a fixing point. It shall be as close as possible to the fixing point and in any case shall be rigidly connected to the fixing point. If 4 or less fixing points exist, each shall be used as a control point. If more than 4 fixing points exist, 4 representative points shall be selected and specified for use as control points.

NOTE — For large and/or complex equipment, the control points shall be defined in the relevant equipment specification.

2.5 Fixing Point — A part of the equipment in contact with the fixture or vibration table at a point where the equipment is normally fastened in service. If a part of real mounting structure is used as the fixture, the fixing point shall be taken as that of mounting structure and not of the equipment.

2.6 Reference Point — The single point from which the reference signal is obtained to confirm the test requirement and is taken to represent the motion of the equipment. It may be a control point, or an imaginary point created by a manual or automatic processing of the signals from the control points. Unless otherwise specified, the signal from the reference point shall be the average of signals from the control points. The relevant equipment specification shall state the point to be used or how it should be chosen. It is recommended that for large and/or complex equipment an imaginary point be used.

2.7 Vibration Amplitude — The amplitude specified in terms of constant displacement or constant velocity or constant acceleration. The term 'amplitude' is used in the wider sense of peak value of an oscillating quantity. Each value of displacement amplitude is associated with the corresponding value of velocity or acceleration amplitude. The relationship is as follows:

$$\text{Acceleration (m/s}^2\text{)} = \frac{4\pi^2 f^2}{1\,000} \text{. displacement (mm)}$$

$$\text{Velocity (m/s)} = \frac{2\pi f}{1\,000} \text{. displacement (mm)}$$

where f is frequency in Hz.

NOTE — For any combination of displacement and acceleration amplitude or displacement and velocity amplitude, a crossover frequency can be calculated from the above relationship, so that the magnitude of vibration is same at this frequency. Hence, a frequency range may be swept continuously, changing from constant displacement to constant acceleration (for constant velocity) and vice versa at the crossover frequency.

2.8 Single Point Control — This is achieved by using the signal from the transducer at the reference point in order to maintain this point at the specified level.

2.9 Multipoint Control — This is achieved by using the signal from each transducer at the check points and either continuing arithmetical averaging or comparing depending upon the relevant specification.

3. OBJECT

3.1 The object of this test is to provide a standard procedure to determine the ability of components, equipment and other articles to withstand specified severities of sinusoidal vibration.

4. GENERAL DESCRIPTION

4.1 The purpose of this test is to determine mechanical weakness and/or degradation in specified performance and to use the information, in conjunction with the relevant specification, to decide whether an equipment or component, hereinafter referred to as an item, is acceptable or not. It may also be used, in some cases, to determine the structural integrity of items and/or to study their dynamic behaviour.

4.2 Whether an item has to function during vibration or merely to survive, conditions of vibration will need to be stated in the relevant specification.

4.3 It is emphasized that vibration testing always demands a certain degree of engineering judgement and, for this reason, care shall be exercised while selecting the test requirements and interpreting the results.

4.4 The main part of this standard deals primarily with the methods of controlling the test at specified points and gives, in detail, the testing procedure. The requirements for vibration motion, choice of severities including frequency ranges, amplitudes and endurance times are also specified; the severities representing a rationalized series of parameters. The relevant specification writer is expected to choose the testing procedure and values appropriate to the item and its usage.

4.5 IS : 9001 (Part XIII)-1981* has been prepared in which Appendices are included, giving general guidance and a selection of severities for components and for equipment in order to assist users.

4.6 Certain terms have been defined to facilitate a proper understanding of the text. These definitions are given in **2**.

5. DESCRIPTION OF TEST APPARATUS

5.1 General — The required characteristics of the vibration generator and fixture, when the generator is loaded for conditioning processes, shall be as follows.

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

5.1.1 *Basic Motion* — The basic motion shall be sinusoidal and such that the fixing points of the item are moving substantially in phase and in straight parallel lines, except as in **5.1.2** and **5.1.3**.

5.1.2 *Transverse Motion* — The maximum vibration amplitude at the fixing points in any direction perpendicular to the intended direction (including that due to rocking, torsional vibration, etc) shall not exceed 25 percent of the specified amplitude.

NOTE — In some cases, for example, for large items, it may be difficult to maintain a limit of 25 percent. In such cases, the value shall be noted and agreed between the customer and the supplier.

5.1.3 *Distortion* — The total rms harmonic content of the acceleration corresponding to the specified amplitude at the driving frequency shall not exceed 25 percent, unless compensated for by increasing the driving amplitude so as to restore the amplitude at the fundamental frequency to the specified value. In such cases, the distortion value shall be noted and stated in the test report.

The distortion measurement shall cover the frequency up to 5 000 Hz or 5 times the driving frequency, whichever is greater.

5.1.4 *Vibration Amplitude Tolerances* — The actual vibration amplitude in the required direction shall be equal to the specified value within the following tolerances:

a) At the reference point (which may be specified by the relevant specification):

   i) In the frequency range where displacement amplitude is specified — ±15 percent

   ii) In the frequency range where acceleration amplitude is specified — ±10 percent

b) At each specified control point:

Frequency	*In the Frequency Range where Displacement Amplitude is Specified*	*In the Frequency Range where Acceleration Amplitude is Specified*
Up to 150 Hz	±25 percent	±15 percent
Above 150 Hz	—	±25 percent

NOTE 1 — In some cases, for example, for large items and/or at high frequencies, it may be difficult to achieve the figures quoted at some discrete frequencies within the range. In such cases, it is expected that a wider tolerance or an alternative method of assessment will be specified and stated in the test report.

NOTE 2 — There should be no substantial difference in the amplitude recorded at different control points.

5.1.5 *Frequency Tolerances* — Measurement of frequency for resonance determination shall be made with a tolerance of ±0·5 percent, or ±0·5 Hz, whichever be the greater.

5.1.5.1 Frequency tolerances in other cases shall be ±1 Hz up to 50 Hz and ±2 percent over 50 Hz.

5.1.6 *Driving Force* — When required, control of vibration amplitude shall be supplemented by a limitation of the driving force applied to the vibrating system. The method of force limitation (for example, based on measured driving current or force transducer) shall be as stated. Unless otherwise specified, the peak driving force shall be limited to a level not less than *m. a.* newtons,

where

m = mass of the complete moving assembly (that is, vibration table, drive coil, jig or fixture and item under test, etc) in kg; and

a = required acceleration level in m/s^2.

5.1.7 *Ambient Temperature Range* — The vibration test system and the instrument console shall be capable of operating over the ambient temperature of 10 to 40°C.

5.1.8 *Sweep* — The sweeping when provided shall be continuous [*see* **6.3** of IS : 9001 (Part XIII)-1981*] and logarithmic, and the sweep rate shall be approximately one octave per minute. A linear sweeping approximation may be used provided the actual sweep rate does not exceed one octave per minute at any time and the duration of passage through each octave above 60 Hz is approximately the same as with the logarithmic sweep. Provision should be made for the temporary stopping of the sweep at any desired point of the frequency ranges.

5.2 Mounting — Mounting of items is dealt with in IS : 9001 (Part XII)-1977†.

For items normally mounted on isolators, *see*, in addition, **5.1**, **5.2** and **5.7** of IS : 9001 (Part XIII)-1981*.

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.
†Guidance for environmental testing: Part XII Mounting of electronic and electrical items for dynamic tests.

6. SEVERITIES

6.0 A vibration severity is defined by the combination of parameters like frequency range, vibration amplitude and duration of endurance (in sweep cycles or time).

For each parameter, the relevant specification shall choose the appropriate requirements from those listed below. If the known environment, however, is substantially different, the requirements shall be related to it by the relevant specification.

Examples of severities for equipment are given in Appendix A and for components in Appendix B of IS : 9001 (Part XIII)-1981*.

6.1 Frequency Range — The frequency range shall be given in the relevant specification by selecting a lower frequency from Table 1 and a higher frequency from Table 2.

The recommended ranges are shown in Table 3.

TABLE 1
LOWER FREQUENCY

f_1
Hz
0·1
1
5
7
10
55
100

TABLE 2
UPPER FREQUENCY

f_2
Hz
10
20
35
55
100
150
300
500
2 000
5 000

TABLE 3
RECOMMENDED FREQUENCY RANGES

from f_1 to f_2
Hz
1–35
1–100
5–35
5–150
5–350
5–500
5–2 000
7–300
10–55
10–150
10–500
10–2 000
10–5 000
55–500
55–2 000
55–5 000
100–2 000

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

6.2 Vibration Amplitude — The vibration amplitude (displacement or acceleration or both) shall be given in the relevant specification.

Below a certain frequency known as the 'crossover frequency' all amplitudes are specified as constant displacement, above this frequency, while amplitudes are given as constant acceleration. The recommended values are given in Tables 4 and 5 and Fig. 1, 2 and 3, for two different crossover frequencies.

Each value of displacement amplitude is associated with a corresponding value of acceleration amplitude (shown on the same line in Tables 4 and 5), so that the magnitude of vibration is the same at the crossover frequency [*see* **6.1** of IS : 9001 (Part XIII)-1981*].

Where it is not technically appropriate to adopt the crossover frequencies stated in this clause, the relevant specification may couple displacement and acceleration amplitudes giving a different value of crossover frequency. In some circumstances, more than one crossover frequency may also be specified.

Up to an upper frequency of 10 Hz, it is normally appropriate to specify a displacement amplitude over the whole frequency range. Therefore, in Table 6 and Fig. 3, only displacement amplitudes are specified.

TABLE 4 RECOMMENDED VIBRATION AMPLITUDES WITH CROSSOVER FREQUENCY 8 to 9 Hz

Displacement Amplitude Below Crossover Frequency	Acceleration Amplitude Above Crossover Frequency	
mm	m/s^2	(g_n)
(1)	(2)	(3)
0·35	1	(0·1)
0·75	2	(0·2)
1·5	5	(0·5)
3·5	10	(1·0)
7·5	20	(2·0)
10	30	(3·0)
15	50	(5·0)

Note 1 — All figures quoted are amplitudes (peak values).
Note 2 — The g_n values ($g_n = 10$ m/s^2) are given for information.

Note 3 — The displacement amplitude of 15 mm is primarily intended for hydraulic vibration generators.

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

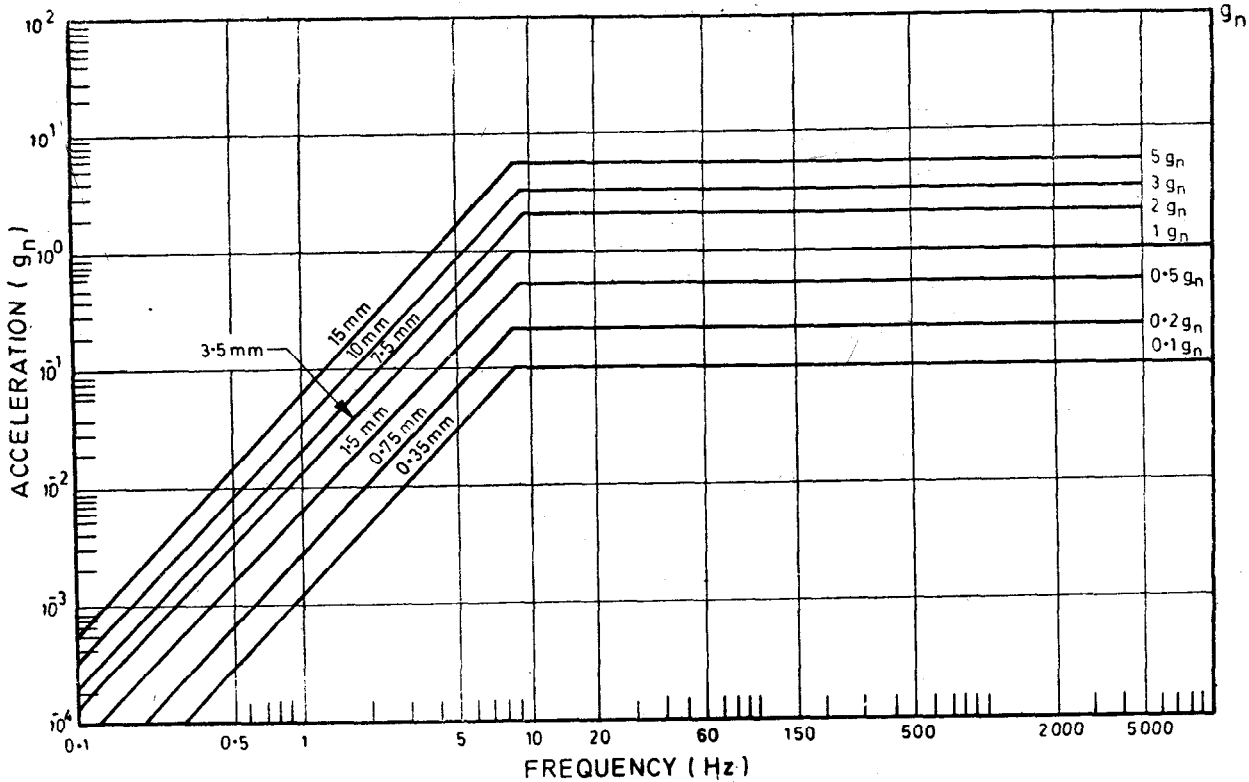

FIG. 1 VIBRATION AMPLITUDE WITH LOWER CROSSOVER FREQUENCY, 8 TO 9 Hz.

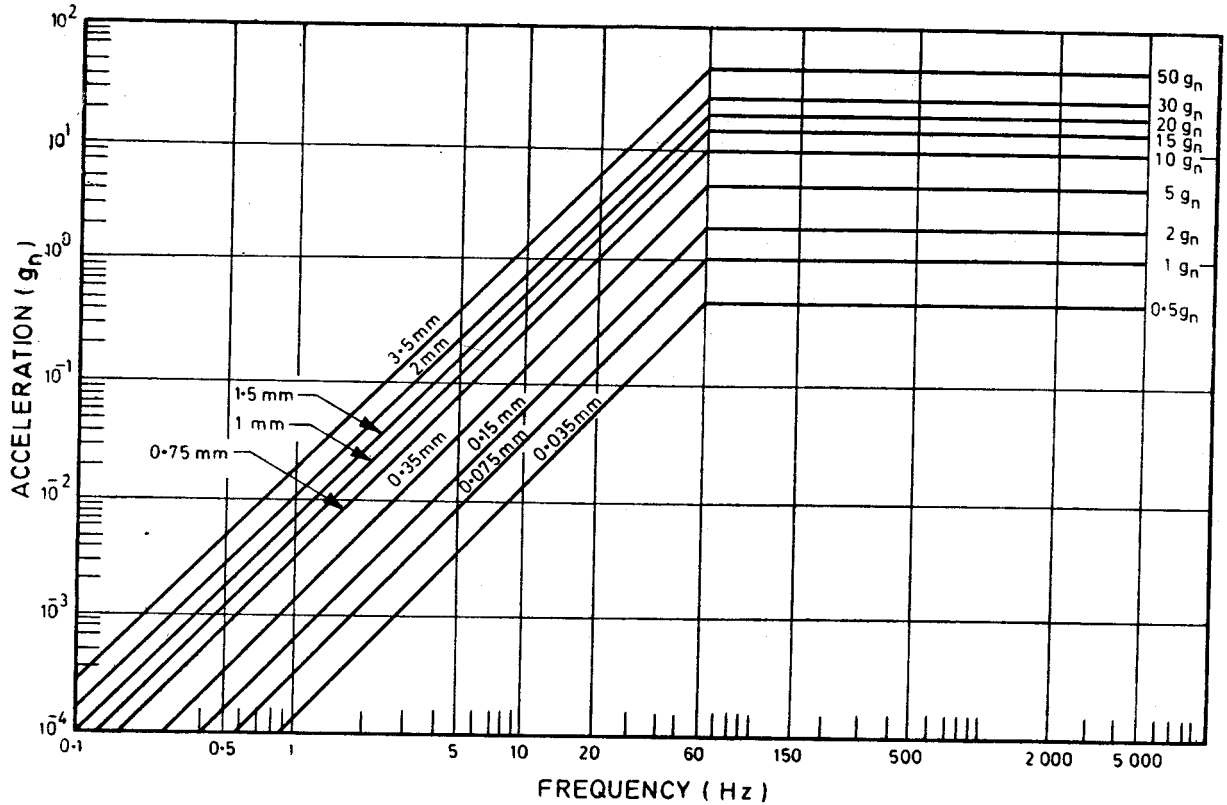

FIG. 2 VIBRATION AMPLITUDE WITH HIGHER CROSSOVER FREQUENCY, 57 TO 62 Hz

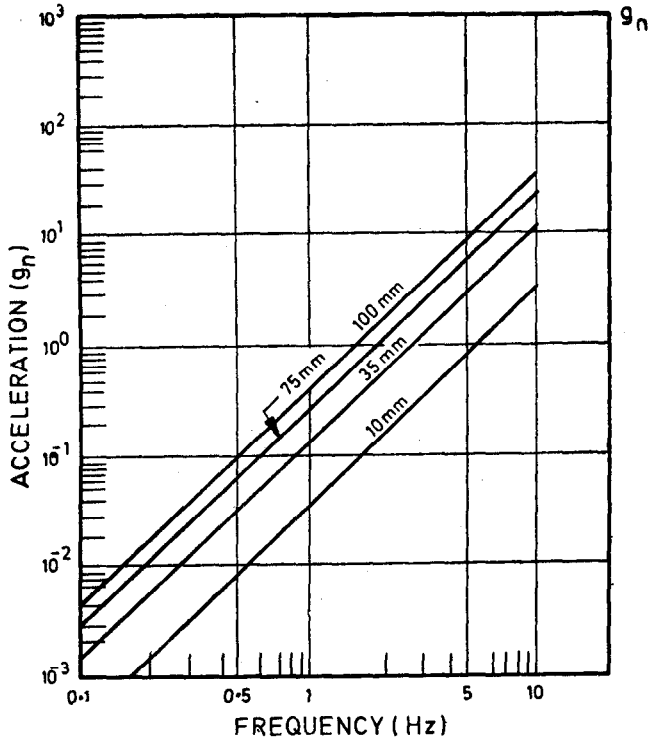

FIG. 3 VIBRATION DISPLACEMENT AMPLITUDE, ONLY APPLICABLE FOR FREQUENCY RANGES WITH AN UPPER FREQUENCY OF 10 Hz

6.3 Duration of Endurance — The relevant specification shall select the duration(s) from the recommended values given below. If the specified duration leads to an endurance time of 10 hours or more per axis or frequency, this time may be split into periods provided that stresses in the item (due to heating, etc) are not reduced.

6.3.1 *Endurance by Sweeping* — The duration of the endurance in each axis shall be given as a number of sweep cycles (*see* **2.1**) chosen by the relevant specification from the list given below:

1, 2, 5, 10, 12, 15, 16, 20, 24, 30, 50, 100

When a higher number of sweep cycles is required, the same series shall apply [*see* **6.3** of IS : 9001 (Part XIII)-1981*].

TABLE 5 RECOMMENDED VIBRATION AMPLITUDES WITH HIGHER CROSSOVER FREQUENCY 57 to 62 Hz

(*Clause* 6.2)

Displacement Amplitude Below Crossover Frequency	Acceleration Amplitude Above Crossover Frequency	
mm	m/s^2	(g_n)
(1)	(2)	(3)
0·035	5	(0·5)
0·075	10	(1·0)
0·15	20	(2·0)
0·35	50	(5·0)
0·75	100	(10)
1·0	150	(15)
1·5	200	(20)
2·0	300	(30)
3·5	500	(50)

Note 1 — All figures quoted are amplitudes (peak values).
Note 2 — The g_n values ($g_n = 10$ m/s^2) are given for information.

TABLE 6 RECOMMENDED VIBRATION DISPLACEMENT AMPLITUDES ONLY APPLICABLE FOR FREQUENCY RANGES WITH AN UPPER FREQUENCY OF 10 Hz

(*Clause* 6.2)

Displacement Amplitude mm
10
35
75
100

Note 1 — All figures quoted are amplitudes (peak values).
Note 2 — The displacement amplitudes of more than 15 mm are primarily intended for hydraulic vibration generators.

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

6.3.2 *Endurance at Fixed Frequencies*

6.3.2.1 *Endurance at critical frequencies* — The duration of the endurance in each appropriate axis at each frequency found during the vibration response investigation (*see* **9.1**) shall be chosen by the relevant specification from the values given below [*see* **8.2** of IS : 9001 (Part XIII)-1981*]:

10 min ± 0·5 min
30 min ± 1 min
90 min ± 1 min
10 hour ± 5 min

6.3.2.2 *Endurance at predetermined frequencies* — The duration stated in the relevant specification shall take into account the total time the item is expected to be submitted to such vibration during its operational life. An upper limit of 10^7 reversals shall apply for each stated combination of frequency and axis [*see* **8.2** of IS : 9001 (Part XIII)-1981*].

7. PRECONDITIONING

7.1 The relevant specification may call for preconditioning.

8. INITIAL MEASUREMENTS

8.1 The item shall be electrically and mechanically checked as required by the relevant specification [*see* **11** of IS : 9001 (Part XIII)-1981*].

9. CONDITIONING

9.0 The relevant specification shall state the number of axes in which the item shall be vibrated, and their respective positions. In the absence of this requirement, the item shall be vibrated successively in 3 mutually perpendicular axes which shall be so chosen that faults are most likely to be revealed.

The test procedure to be applied shall be chosen, by the relevant specification, from the stages given below. Guidance is given in Appendices A and B of IS : 9001 (Part XIII)-1981*. In general, the test stages shall be performed in sequence in the same axis and then repeated for the other axes [*see* **5** of IS : 9001 (Part XIII)-1981*].

Special action is necessary when an item normally intended for use with vibration isolators needs to be tested without them [*see* **7** of IS : 9001 (Part XIII)-1981*].

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

When called for by the relevant specification, control of the specified vibration amplitude shall be supplemented by a maximum limit of the driving force applied to the vibrating system. The method of force limitation shall be stated in the relevant specification [*see* **9** of IS : 9001 (Part XIII)-1981*].

9.1 Vibration Response Investigation — When called for in the relevant specification, the frequency range shall be traversed in order to study the behaviour of the item under vibration. Normally, the response investigation shall be carried out over a sweep cycle under the same conditions as for the endurance (*see* **9.2**), but the vibration amplitude and the sweep rate may be decreased below the specified value if thereby more precise determination of the response characteristics can be obtained. Undue dwell time should be avoided.

The item shall be functioning during this response investigation, if required by the relevant specification. Where mechanical vibration characteristics cannot be assessed because the item is functioning, an additional response investigation with the item not functioning shall be carried out.

During the procedure, the item shall be examined in order to determine critical frequencies at which:

a) item malfunctioning and/or deterioration of performance are exhibited which are dependent on vibration; and

b) mechanical resonances and other response effects, for example, chatter, occur.

All frequencies and applied amplitudes at which these effects occur and the behaviour of the item at these frequencies and amplitudes shall be noted. The relevant specification shall state what action shall be taken.

In certain circumstances, the relevant specification may require an additional response investigation on completion of an endurance procedure, so that the critical frequencies before and after can then be compared. The relevant specification shall state what action shall be taken if any change of frequency occurs. It is essential that both response investigation are carried out in the same manner and at the same vibration amplitudes.

9.2 Endurance Procedures — The relevant specification shall prescribe which of the following endurance procedures shall be employed.

9.2.1 *Endurance by Sweeping* — This endurance procedure is *preferred.*

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

The frequency shall be swept over the frequency range at the amplitude and for the duration selected by the relevant specification (*see* **6**). If, necessary, the frequency range may be sub-divided provided that the stresses in the item are not reduced.

9.2.2 *Endurance at Fixed Frequencies* — Vibration shall be applied either at

a) those frequencies derived from the vibration response investigation given in **9.1**, or

b) predetermined frequencies stated in the relevant specification.

The test shall be applied at the amplitude and for the duration stated in the relevant specification [*see* **5.2** of IS : 9001 (Part XIII)-1981*].

In the case of a frequency derived from the vibration response investigation, the applied frequency shall always be maintained at the actual critical frequency.

NOTE 1 — If the actual critical frequency is not clearly evident, for example, chatter, or where a number of individual items are being tested simultaneously, it may be convenient to sweep over a restricted frequency range around the control frequency in order to be sure of exciting the effect fully.

NOTE 2 — In the case of an item mounted on isolators, the relevant specification shall state whether or not the response frequencies of the item on its isolators should be chosen for this endurance [*see* **7** of IS : 9001 (Part XIII)-1981*].

10. INTERMEDIATE MEASUREMENTS

10.1 When called for by the relevant specification, the item shall be functioning and its performance checked during the conditioning for the specified proportion of the total time [*see* **5.2** and **10** of IS : 9001 (Part XIII)-1981*].

11. RECOVERY

11.1 Under certain circumstances, it may be necessary to provide a period of time after the conditioning in which to allow the item to attain the same conditions as existed for the initial measurements, for example, as regards temperature.

12. FINAL MEASUREMENTS

12.1 The item shall be electrically and mechanically checked as required by the relevant specification [*see* **11** of IS : 9001 (Part XIII)-1981*].

*Guidance for environmental testing: Part XIII Vibration (sinusoidal) test.

13. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

13.1 When this test is included in a relevant specification, the following details shall be given as far as they are applicable. The specification writer shall supply information as required in the clauses listed below, paying particular attention to the items marked with an asterisk (*) where this information is always required:

		Clause Ref
a)	Control points	**2.4**
b)	Transverse motion	**5.1.2**
c)	Distortion	**5.1.3**
d)	Derivation of reference signal	**5.1.4**
e)	Tolerances at check points	**5.1.4**
f)	Mounting of items	**5.2**
g)	Frequency range*	**6.1**
h)	Vibration amplitude*	**6.2**
j)	Special crossover frequency	**6.2**
k)	Duration of endurance*	**6.3**
m)	Pre-conditioning	**7**
n)	Initial measurements*	**8**
p)	Axes of vibration	**9**
q)	Force limitation	**9**
r)	Test stages to be performed and sequence*	**9**, **9.1** and **9.2**
s)	Any functioning and functional checks*	**9.1** and **10**
t)	Action to be taken after the vibration response investigation	**9.1**
u)	Action to be taken if a change of response frequency is found when a final response investigation is performed	**9.1**
v)	Predetermined frequencies	**9.2.2**
w)	Conditioning at the resonance frequencies of the item on its isolators	**9.2.2**
y)	Final measurements*	**12**

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* Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Maniktola, CALCUTTA 700054	37 86 62
Northern	: SCO 445-446, Sector 35-C, CHANDIGARH 160036	2 18 43
Southern	: C.I.T. Campus, IV Cross Road, MADRAS 600113	41 29 16
† Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093	6 32 92 95

Branch Offices :	
'Pushpak', Nurmohamed Shaikh Marg, Khanpur, AHMADABAD 380001	2 63 48
‡ Peenya Industrial Area, 1st Stage, Bangalore-Tumkur Road, BANGALORE 560058	39 49 55
Gangotri Complex, 5th Floor, Bhadbhada Road, T.T. Nagar, BHOPAL 462003	55 40 21
Plot No. 82/83, Lewis Road, BHUBANESHWAR 751002	5 36 27
Kalai Kathir Building, 6/48-A Avanasi Road, COIMBATORE 641037	2 67 05
Quality Marking Centre, N.H. IV, N.I.T., FARIDABAD 121001	—
Savitri Complex, 116 G. T. Road, GHAZIABAD 201001	8-71 19 96
53/5 Ward No. 29, R.G. Barua Road, 5th By-lane, GUWAHATI 781003	3 31 77
5-8-56C L. N. Gupta Marg, (Nampally Station Road) HYDERABAD 500001	23 10 83
R14 Yudhister Marg, C Scheme, JAIPUR 302005	6 34 71
117/418 B Sarvodaya Nagar, KANPUR 208005	21 68 76
Plot No. A-9, House No. 561/63, Sindhu Nagar, Kanpur Road, LUCKNOW 226005	5 55 07
Patliputra Industrial Estate, PATNA 800013	6 23 05
District Industries Centre Complex, Bagh-e-Ali Maidan, SRINAGAR 190011	—
T. C. No. 14/1421, University P. O., Palayam, THIRUVANANTHAPURAM 695034	6 21 04

Inspection Offices (With Sale Point) :	
Pushpanjali, First Floor, 205-A West High Court Road, Shankar Nagar Square, NAGPUR 440010	52 51 71
Institution of Engineers (India) Building, 1332 Shivaji Nagar, PUNE 411005	5 24 35

*Sales Office Calcutta is at 5 Chowringhee Approach, P. O. Princep Street, CALCUTTA	27 68 00
† Sales Office is at Novelty Chambers, Grant Road, BOMBAY	89 65 28
‡ Sales Office is at Unity Building, Narasimharaja Square, BANGALORE	22 39 71

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